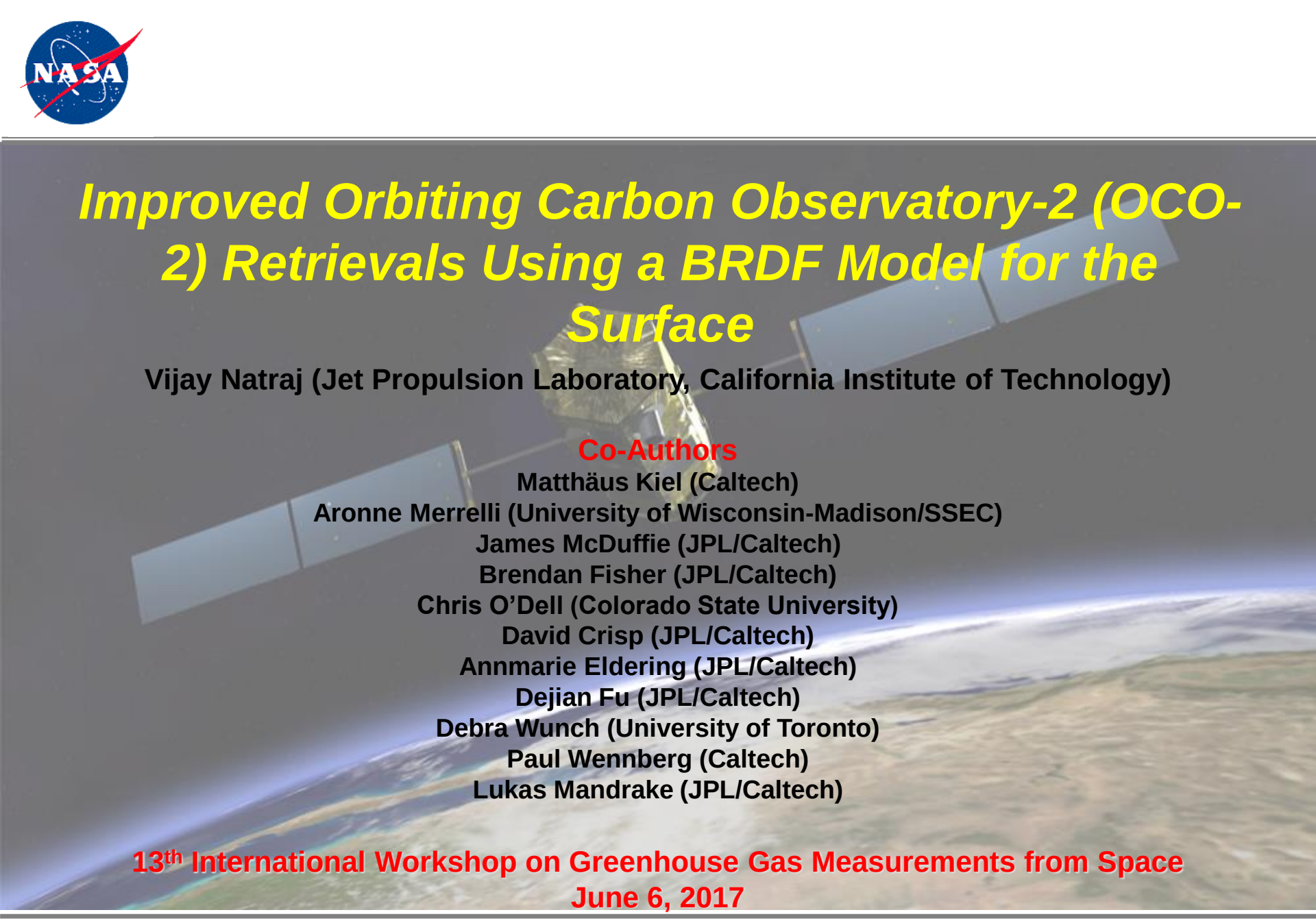

Improved Orbiting Carbon Observatory-2 (OCO-2) Retrievals Using a BRDF Model for the Surface

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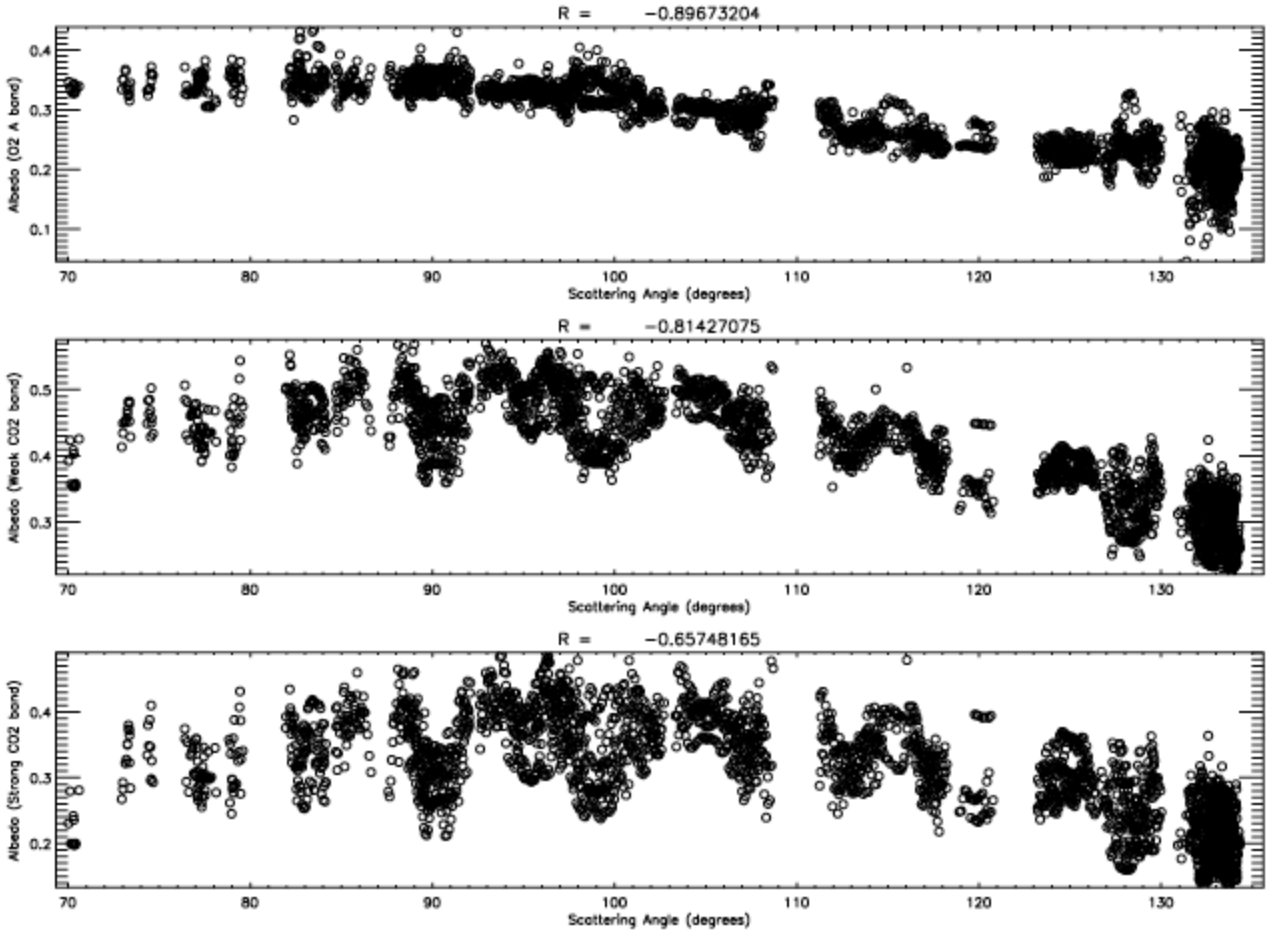
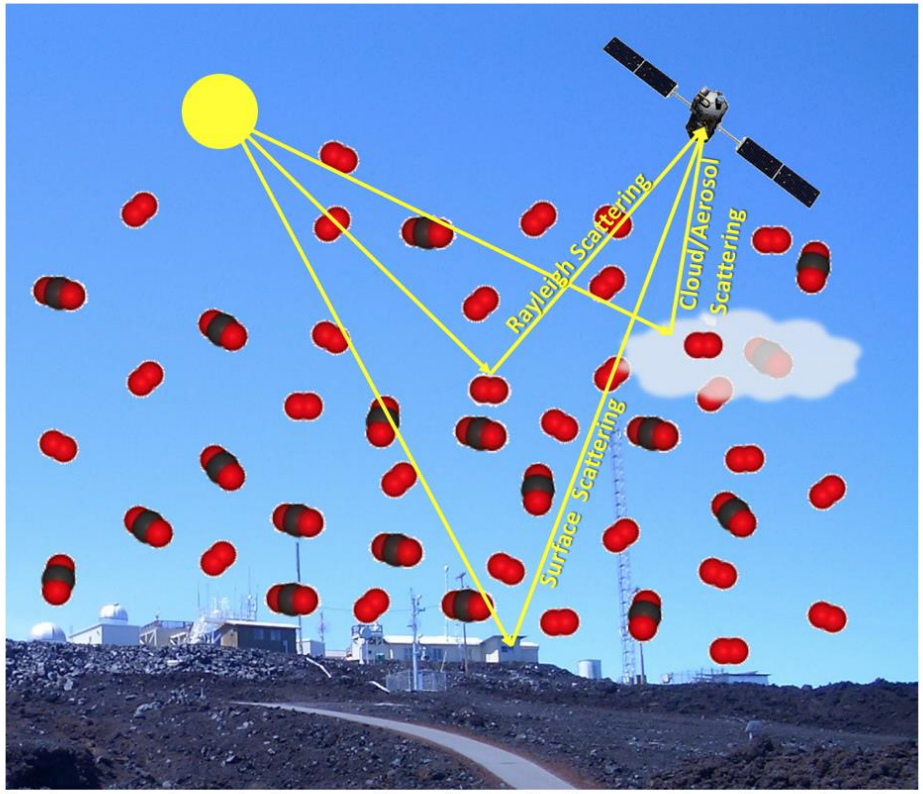
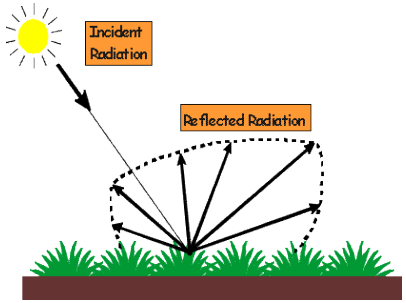
Retrieved Albedo Correlated With Scattering Angle



Retrieved albedo correlated with scattering angle => BRDF effects?

OCO-2 Measurement Geometry



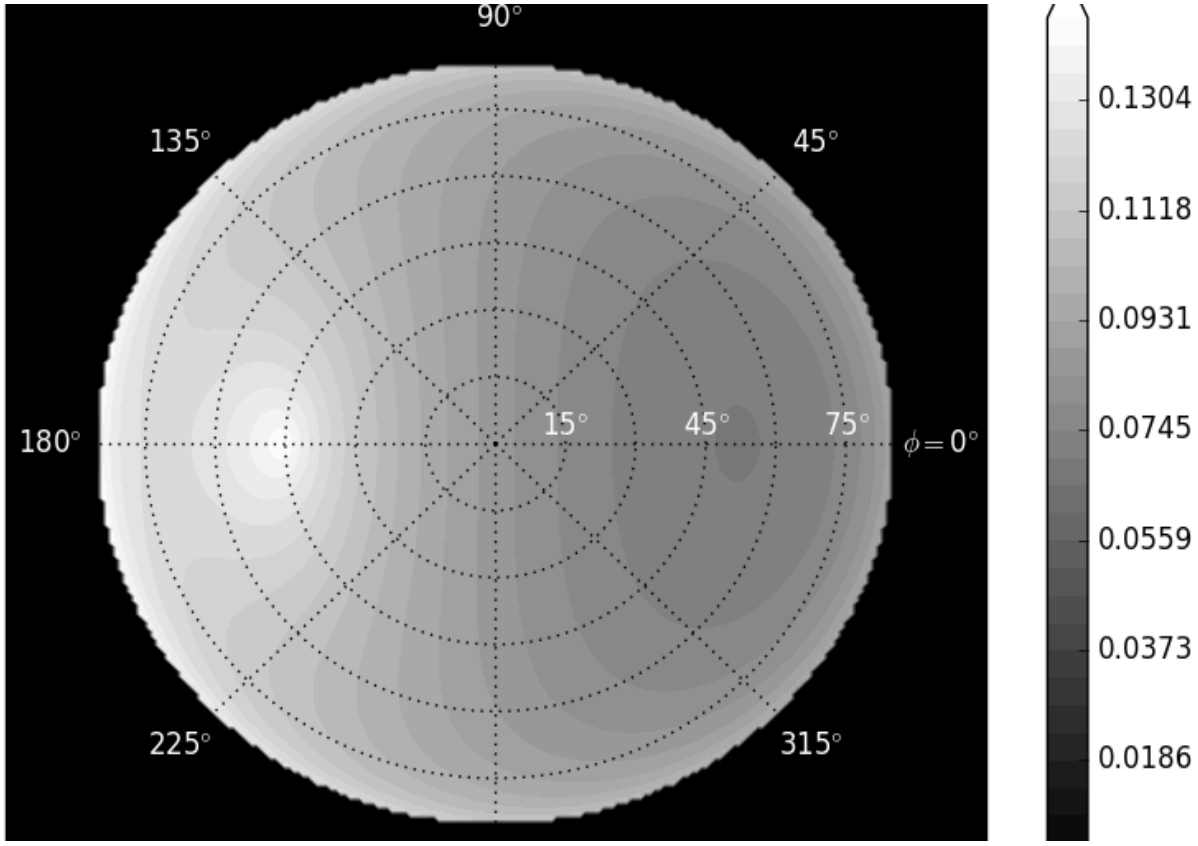


BRDF Formulation

$$BRDF(\lambda) = \left[w + s(\lambda - \lambda_0)\right] F(\rho_0, \Theta, k)$$

- w: overall BRDF amplitude [BRDF weight]
- s: slope of BRDF amplitude [BRDF weight slope]
- λ: wavelength
- λ_0: reference wavelength (where parameters are retrieved)
- F: function describing BRDF shape (RPV kernel)
- ρ_0: hot spot parameter = 0.05
- Θ: asymmetry parameter = −0.1
- k: anisotropy parameter = 0.75
- BRDF kernel reduces to Lambertian kernel for certain choice of BRDF shape parameters
- w, s retrieved

RPV Kernel Shape



BRDF Outputs

- ***w*** **and** ***s*** **converted to more physically meaningful quantities,** ρ_w **(reflectance) and** ρ_s **(reflectance slope)**

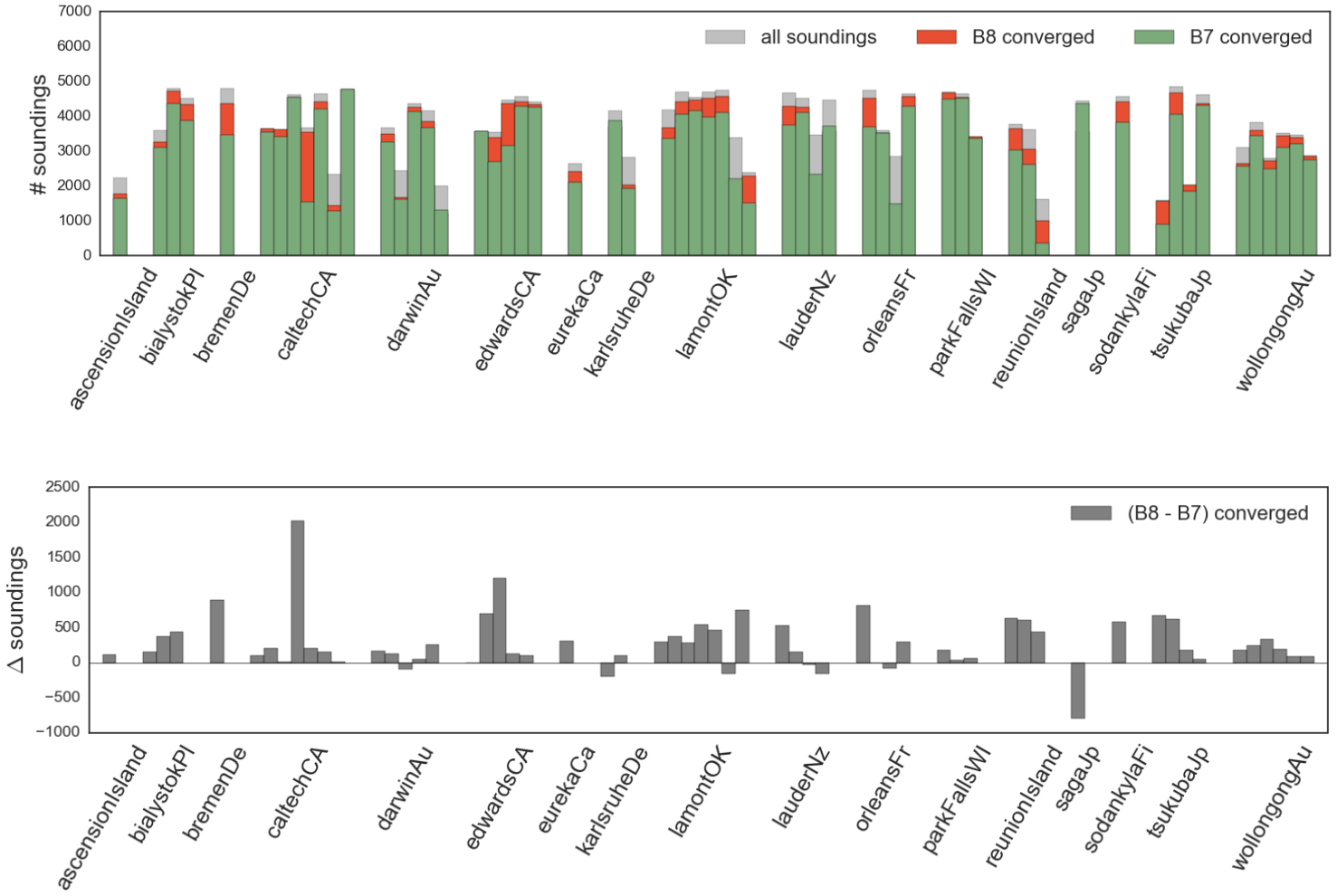
- ρ_w **and** ρ_s **calculated by evaluating the BRDF kernel model at the primary observation geometry**

- **Reflectance factor equals ratio between reflected radiance and that from pure Lambertian surface at the same geometry**

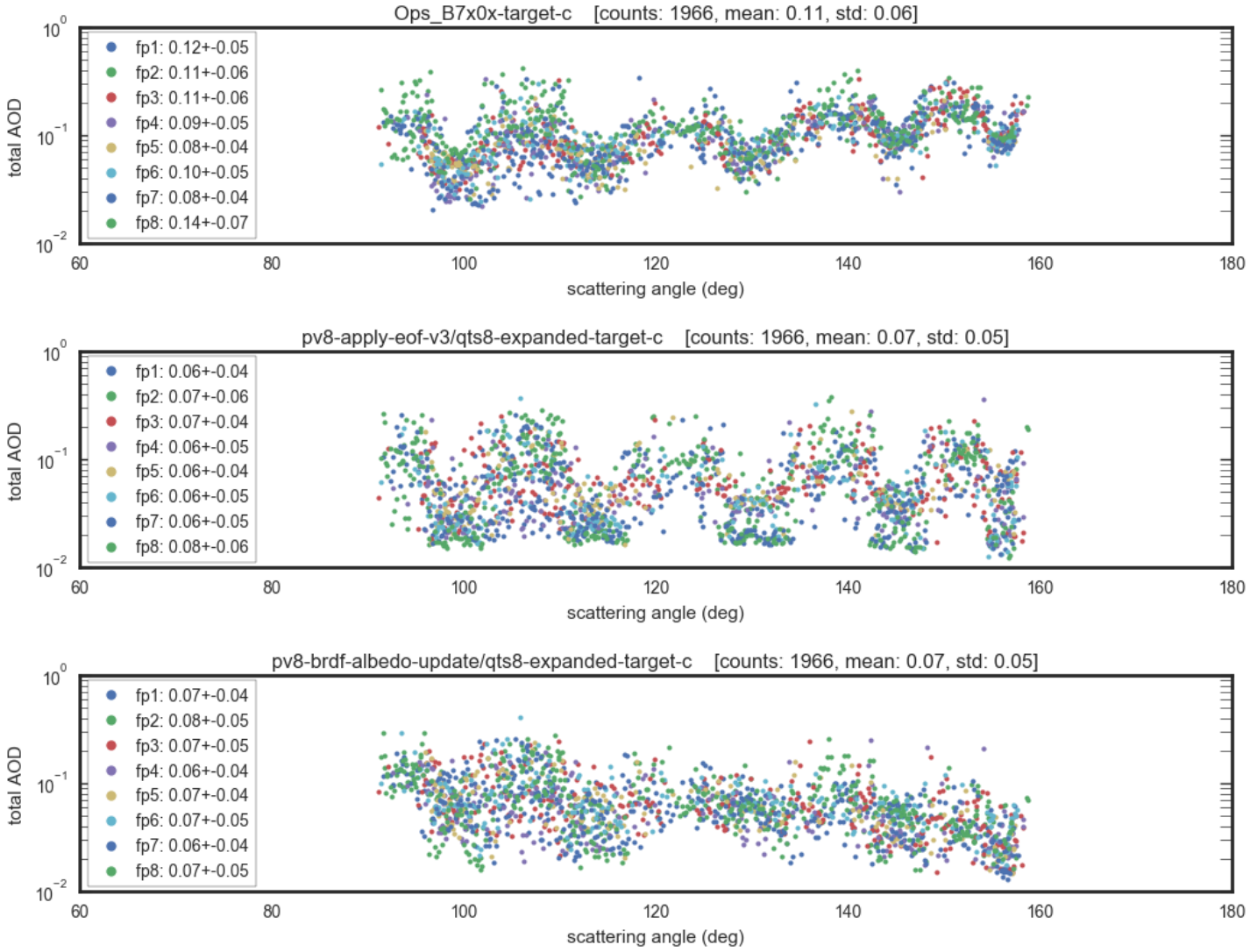
- **For no scattering scenario, this is equivalent to a Lambertian albedo**

- **Consistency between Lambertian albedo used in v7 and effective albedo used in v8**

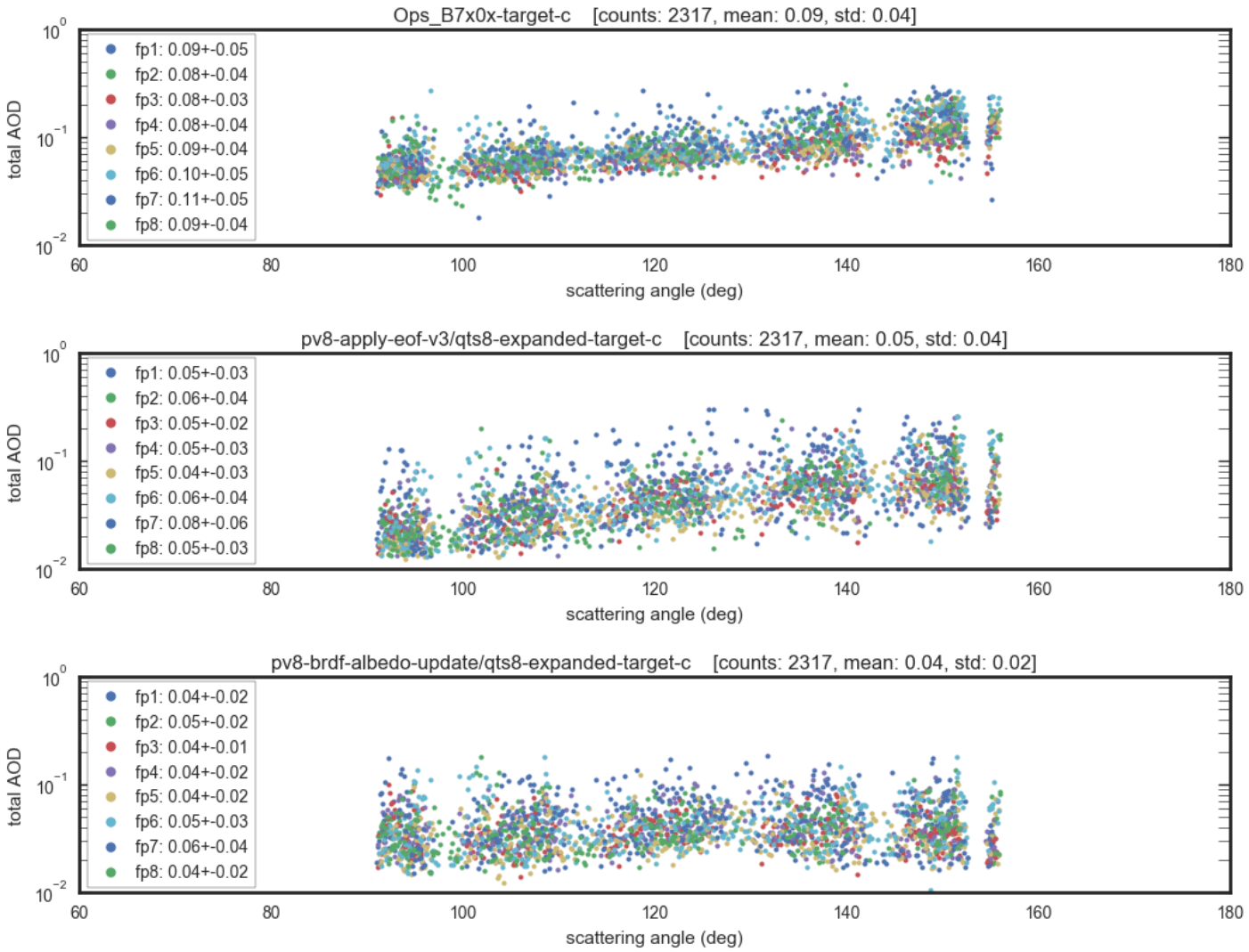
Number of Converged Soundings



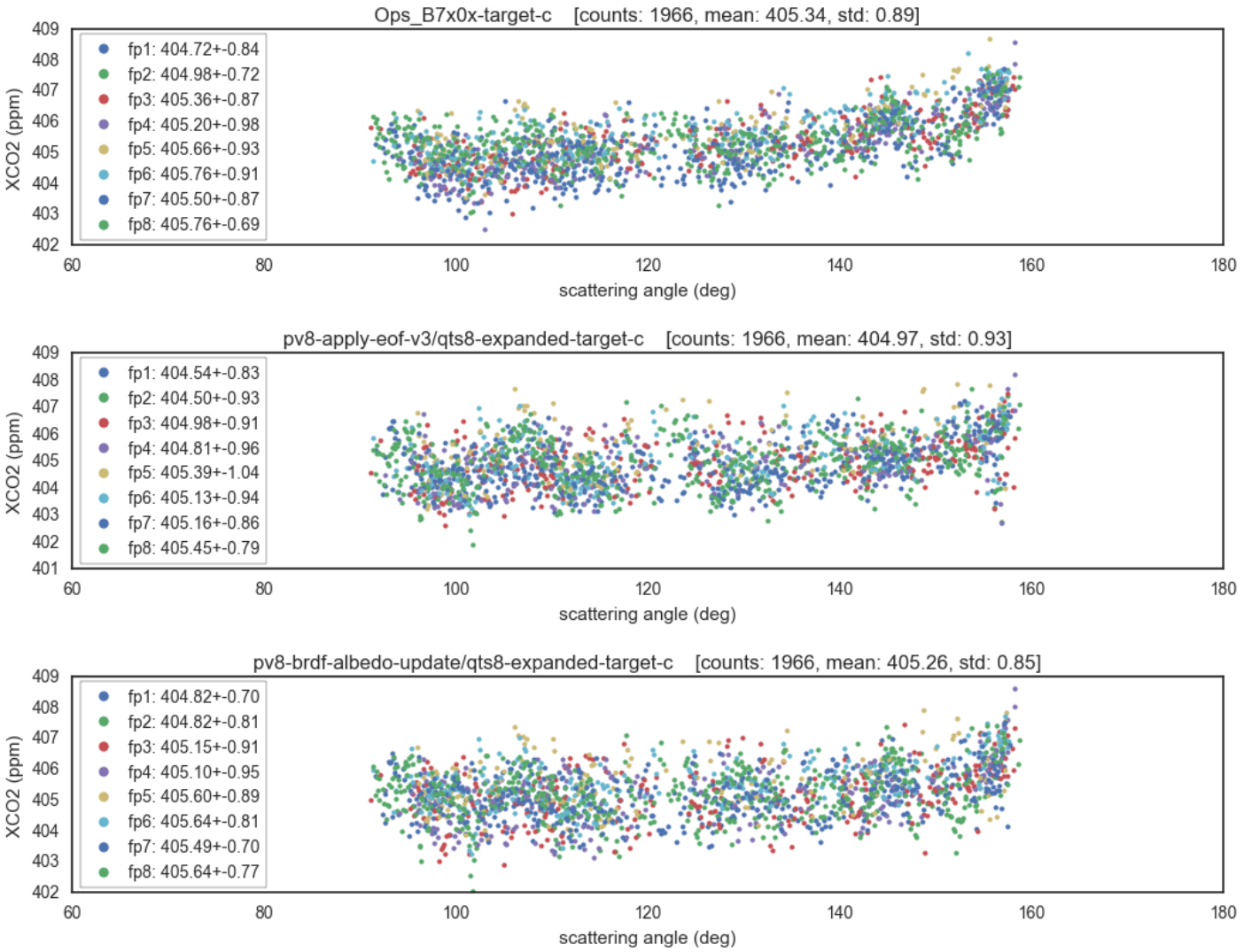
Retrieved AOD (Bremen, 9090)



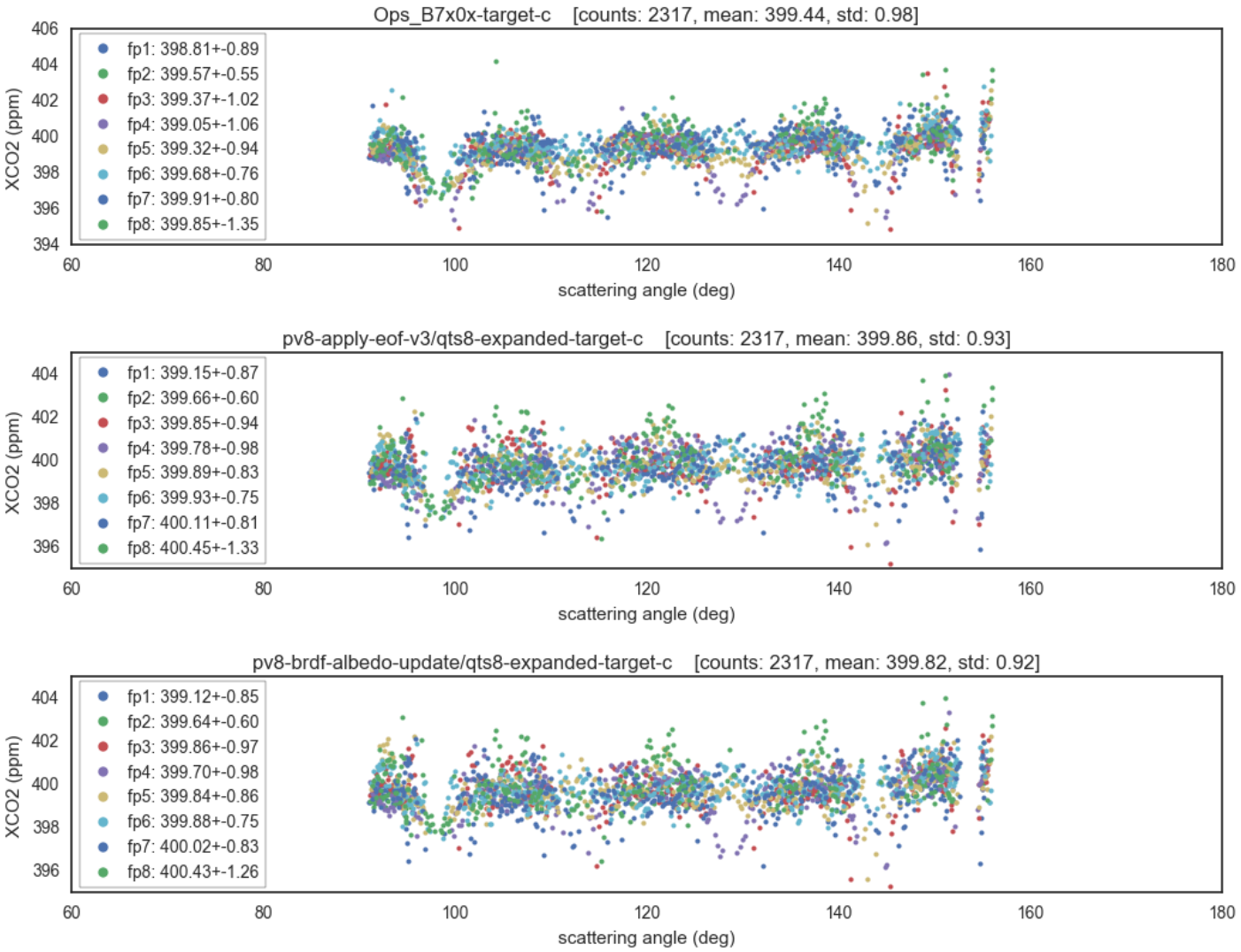
Retrieved AOD (Caltech, 3052)



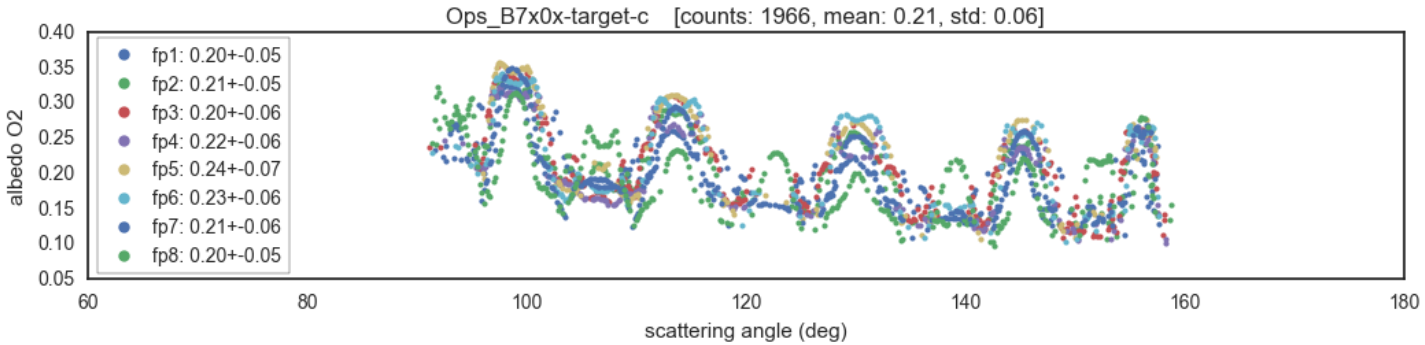
Retrieved XCO2 (Bremen, 9090)

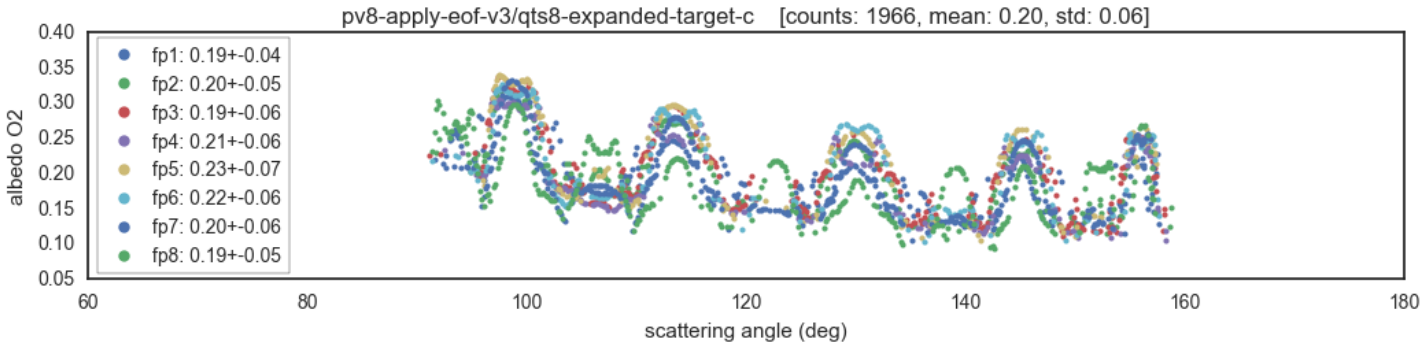


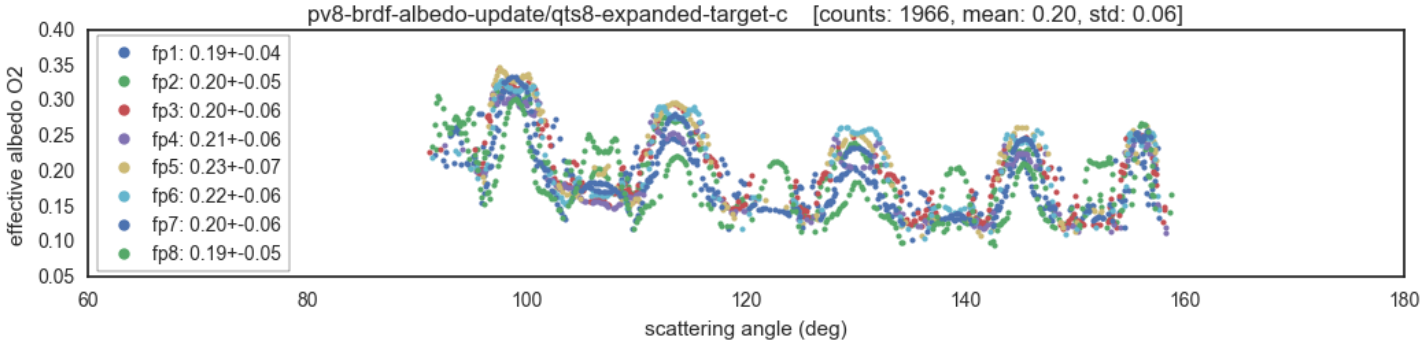
Retrieved XCO2 (Caltech, 3052)



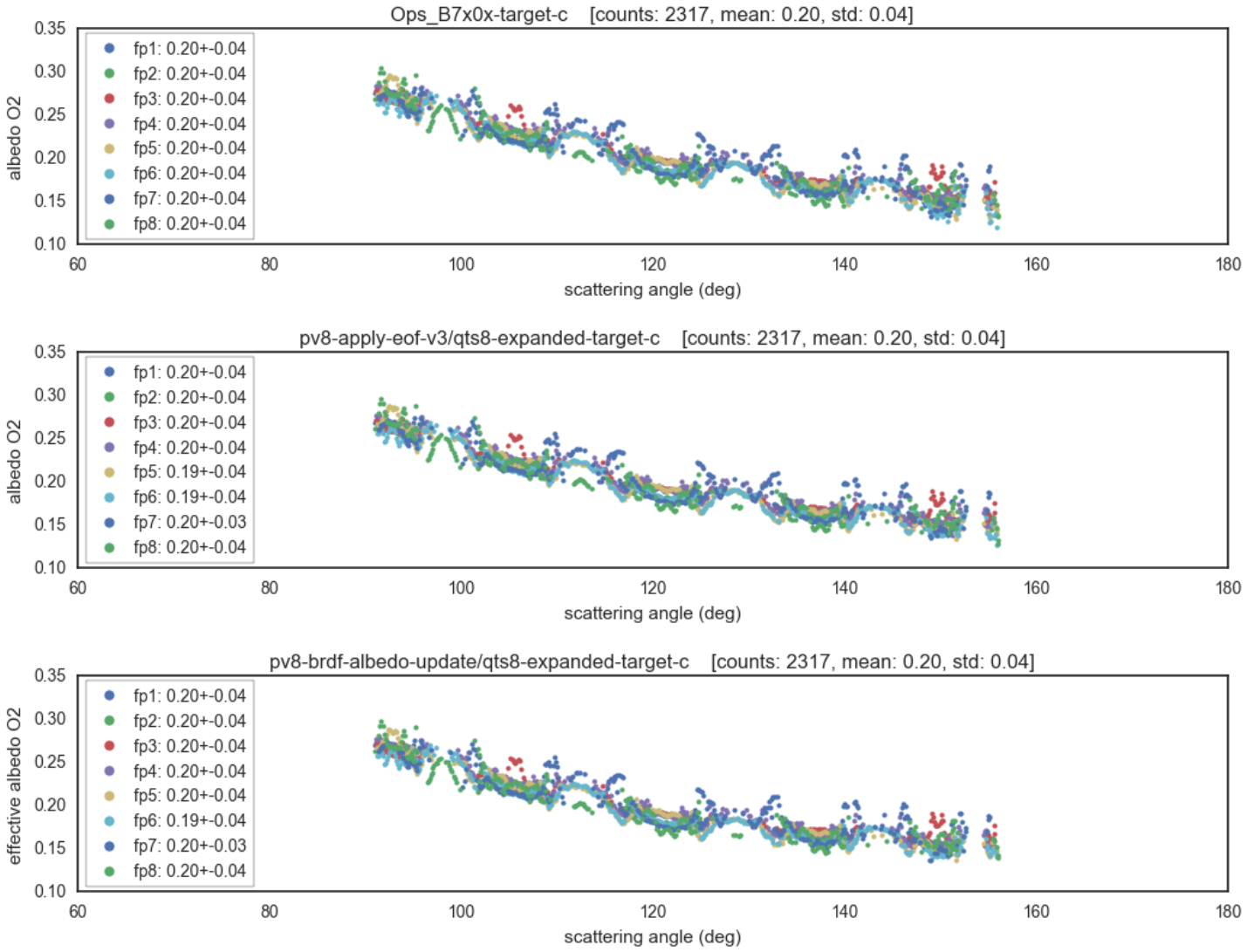
Retrieved Albedo (Bremen, 9090)



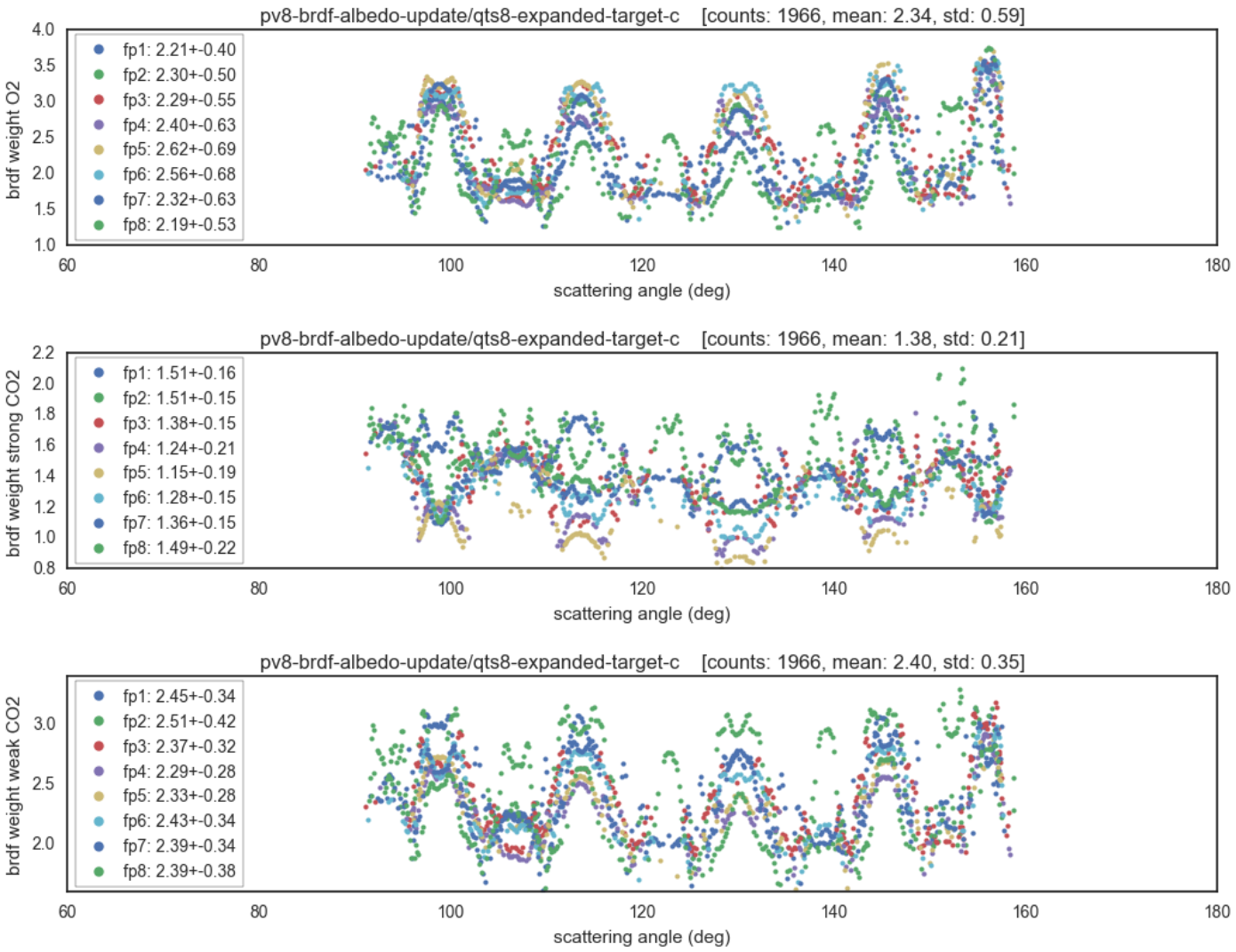




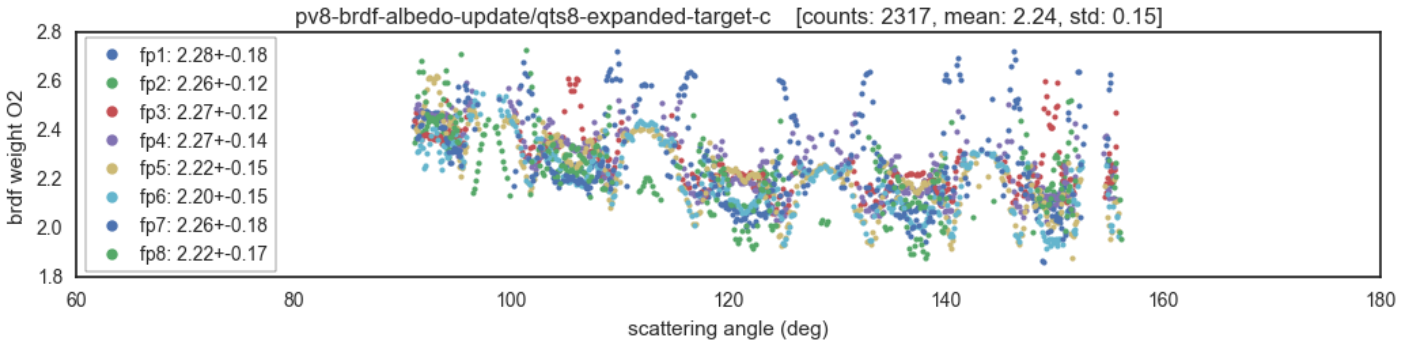
Retrieved Albedo (Caltech, 3052)

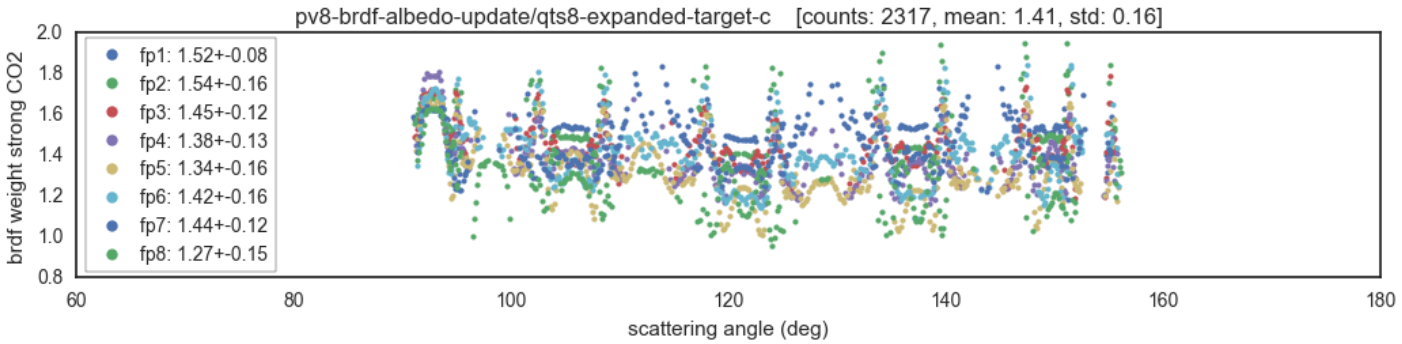


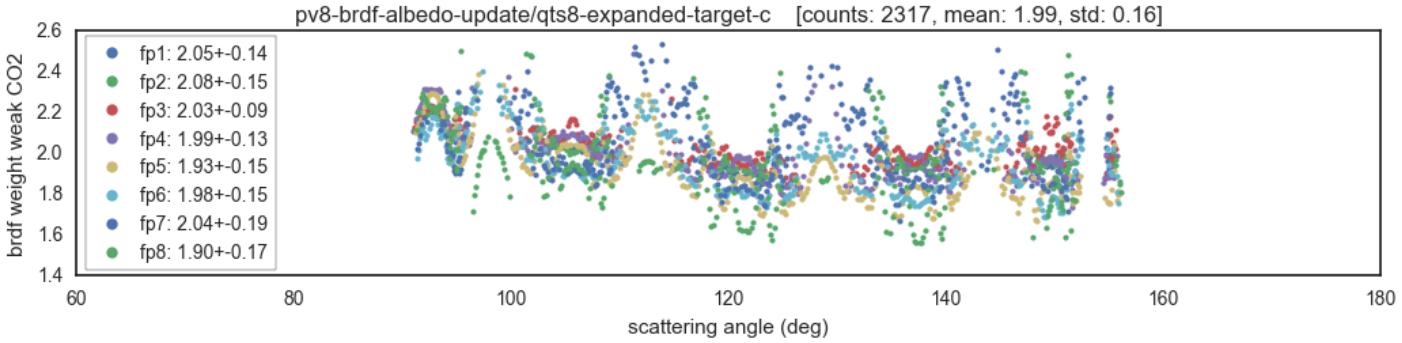
Retrieved BRDF Weights (Bremen, 9090)



Retrieved BRDF Weights (Caltech, 3052)







Conclusions

- **To-do items from last year implemented**
  - ✓ **Re-baseline with new spectroscopic models**
  - ✓ **How do we compare Lambertian and BRDF results**
  - ✓ **Implement BRDF model in operational code**
- **Increased convergence**
- **Improved AOD retrievals**
- **Reduced scatter in XCO2 retrievals**
- **Consistency in albedo values between B7 and B8**
- **Strong correlation of albedo with scattering angle**
- **Little correlation between BRDF weight and scattering angle**

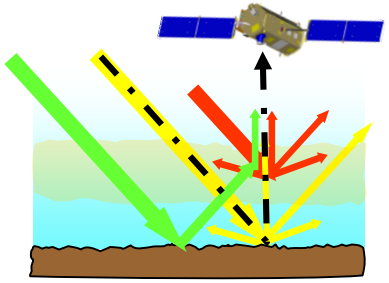
Backup Slides

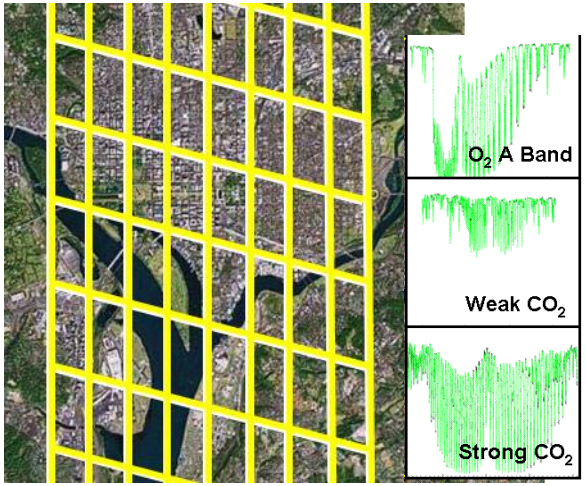
OCO-2 Science Viewing Modes

Nadir Observations:

+ Small footprint (< 3 km²)

– Low Signal/Noise over dark surfaces (ocean, ice)

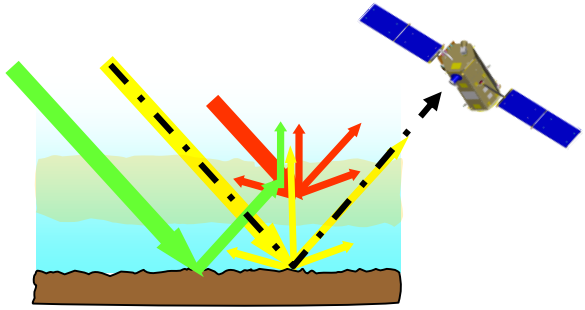


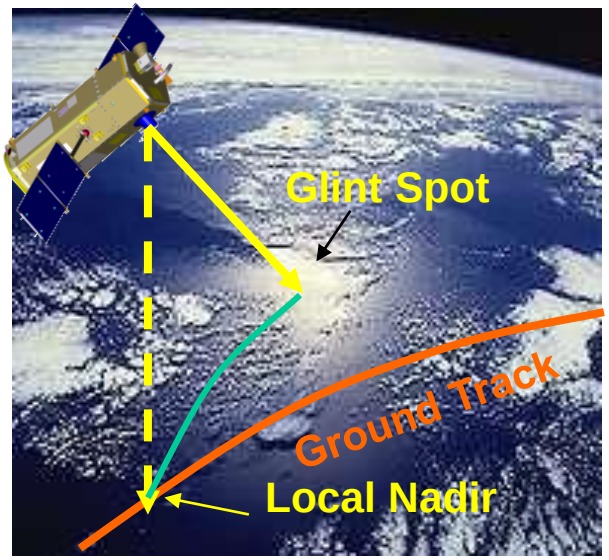


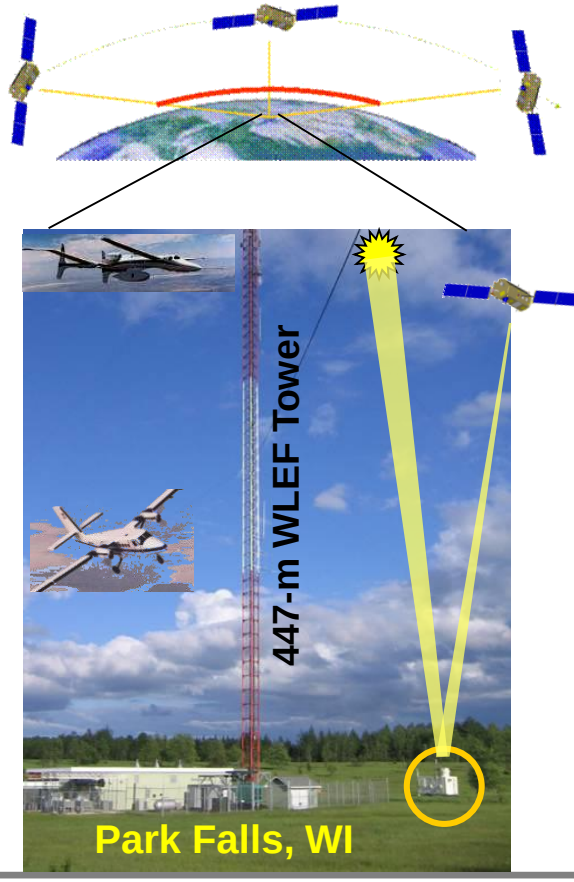
Glint Observations:

+ Improves Signal/Noise over oceans

– More cloud interference





Target Observations:

- Validation over ground based FTS sites, field campaigns, other targets